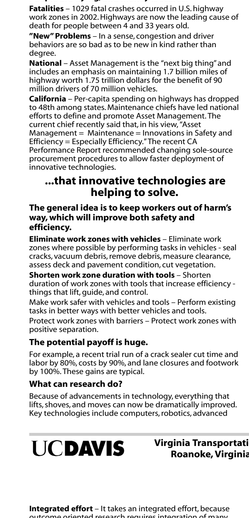
Innovative Highway Technologies



We have a problem...

People are dying, and money is scarce.

Fatalities – 1029 fatal crashes occurred in U.S. highway work zones in 2002. Highways are now the leading cause of death for people between 4 and 33 years old.

"New" Problems – In a sense, congestion and driver behaviors are so bad as to be new in kind rather than degree.

National – Asset Management is the "next big thing" and includes an emphasis on maintaining 1.7 billion miles of highway worth 1.75 trillion dollars for the benefit of 90 million drivers of 70 million vehicles.

California – Per-capita spending on highways has dropped to 48th among states. Maintenance chiefs have led national efforts to define and promote Asset Management. The current chief recently said that, in his view, "Asset Management = Maintenance = Innovations in Safety and Efficiency = Especially Efficiency." The recent CA Performance Report recommended changing sole-source procurement procedures to allow faster deployment of innovative technologies.

...that innovative technologies are helping to solve.

The general idea is to keep workers out of harm's way, which will improve both safety and efficiency.

Eliminate work zones with vehicles – Eliminate work zones where possible by performing tasks in vehicles - seal cracks, vacuum debris, remove debris, measure clearance, assess deck and pavement conditions, coat vegetation.

Shorten work zone duration with tools – Shorten duration of work zones with tools that increase efficiency - things that lift, guide, and control.

Make work safer with vehicles and tools – Perform existing tasks in better ways with better vehicles and tools.

Protect work zones with barriers – Protect work zones with positive separation.

The potential payoff is huge.

For example, a recent trial run of a crack sealer cut time and labor by 80%, costs by 90%, and lane closures and footwork by 100%. These gains are typical.

What can research do?

Because of advancements in technology, everything that lifts, shoves, and moves can now be dramatically improved. Key technologies include computers, robotics, advanced sensors, human interfaces, GPS, GIS, communications, databases, and materials.

We are now in a new "Golden Age" of engineering, because of what electronics and information technology can offer.

Hardware innovation is revolution through evolution, but it can take a relatively long time for innovations to be adopted. In general, the bigger the payoff, the longer it takes.

For example, it took about forty years for factories to organize themselves around electric motors, for cities to organize around cars, and for companies to organize around computers. Only when an innovation incrementally aids in the performance of an existing task can and do things go more quickly.

With the passage of time, we wonder why it took so long for the obvious benefits of electricity, cars, and computers to be appreciated. Yet we are now in the early days of a new wave of mechanical innovation in transportation, and, once again, many are not sure that it is worth it. We now have crack sealers, pothole fillers, debris removers, vegetation cutters, pavement inspectors, and mobile safety barriers ready to go, and these are just the beginning.

Organizations that perform physical tasks have an opportunity to organize themselves around new possibilities and benefit from these technologies as much as Wal Mart benefited from organizing itself around computers.

In general, what are the problems?

In general, the main "problem" with innovation is that success creates new issues. Disruptive technologies are disturbing, and evolutionary technologies are annoying. First you have to **create the innovations**, and then you have to **deploy the innovations**.

Along the way, it helps to hold lots of **workshops** and to sponsor both **projects and programs.**

Creating innovations

To fully achieve the results promised by advances in technology requires sustained, focused, integrated, block research and the will to deploy it.

Sustained effort – It takes a sustained effort, because you must assemble people and provide them the stability needed to develop specialized knowledge, expertise, and understanding of specific situations. In practical terms, this means either an internal research center or a long-term relationship with a university.

Focused effort – It takes a focused effort, because the research must emphasize and be tailored to the unique needs and practices of a single organization.

UCDAVIS

Virginia Transportation Conference 2004
Roanoke, Virginia, October 17- 19

Caltrans

Integrated effort – It takes an integrated effort, because outcome oriented research requires integration of many different technologies. Since only employees know the full details of specialized highway technology, this means a close relationship with your researchers.

Block effort – It takes a block effort, because separate projects and resources should be combined to achieve significant results.

Will to deploy – It takes top-to-bottom will to deploy, because successful research usually disrupts an organization and causes a lot of problems. Entrepreneural problems.

Deploying Innovations

Here are some of the problems related to deploying hardware technology in a transportation environment.

Disruption – Change is inherently upsetting emotionally.

Physical innovations are visible - Prototypes often break or are slightly off target. And an off target prototype that breaks can be extremely annoying.

Field Trials – Field trials are costly and require extra effort by people with regular jobs to do.

Purchasing – Sole-source purchasing is a barrier to deployment. Also needed are best value, design build contracting, best value maintenance purchasing, and functional specification purchasing.

Patents – Patents are necessary to prevent others from stopping you from working on your own ideas.

Documentation and risk management – Doing something new invites lawsuits over old practices. Each deployment must be thoroughly documented in manuals or else you invite some seriously costly lawsuits.

Final product – Should the research product be biddable drawings or prototypes handed off to commercial vendors?

Team work – Innovations require the specialized knowledge and cooperation of three distinct groups: line workers with practical knowledge related to daily tasks, researchers with professional engineering skills, and entrepreneurs who make things happen. There also needs to be support from virtually all levels of management. All must work as a team, which is sometimes not so easy.

Customer – Without customers and champions, innovations, even in a mission oriented organization, are doomed from the beginning.

Workshops

A lot of problems go away if you use workshops to generate ideas, report on progress, and set initial priority rankings. Workshops generate good ideas, promote internal communications, pave the way for deployment, force an accounting for money spent, generate excitement, and bring contractors on board. If a workshop generates an idea for an innovation, the customer and field trial problems never happen. Or if a project stalls out, someone at the workshop can often take charge.

A key idea in workshops is to involve practitioners, managers, researchers, and industry representatives. Workers who know the daily tasks can come up with lots of ideas, managers can balance the priorities, researchers can think out of the box, and industry can provide reality checks. However, when ideas are generated for innovative practices and policies that have little or nothing to do with research, managers need to respond or else seriously demotivate their organization, and researchers need to point out that, by definition, research is about changing tasks not performing tasks as currently defined.

Projects and Programs

If you ask for ideas, you will get ideas for both projects and programs.

Projects help perform tasks in better ways.

Programs transform the tasks themselves.

Projects tend to result in improvements that can be readily deployed. For example, what's the best way to heat snow plows? By definition, projects have an incremental impact on safety and efficiency, and they require that you continually and repeatedly pay for a learning curve related to the needs and practices of an organization.

Programs tend to result in transformation of existing tasks, innovations that are harder to deploy, and major impacts on safety and efficiency. Programs can result in vehicles and equipment, but they typically require a sustained effort over a long period of time. Programs are usually more expensive than projects.

Project proposals are typically published widely so that a wide range of people can bid on them.

Programs are typically performed by a research center and take a long-term commitment from both sides.

Both projects and programs are needed.

What's Hot

Research – Data mining to identify patterns. Controlled studies on pavement preservation variables.

Barriers – Balsi Beam enhancements, tire/axle nets, mobile wire rope, and K rail friction (pin sleeves, space connectors, explosive bolts, adhesives..

Inspection – Voids, levels of service, 40% deterioration.

Pavement – Asphalt metering for potholes. Random and longitudinal crack sealers.

Night work – Lights and signs.

Automated Highway Systems – Responding to cars that can keep lanes, detect obstacles, and adjust speed.

Worker assistance – Arms, tools, and exoskeletons.

What's In the Pipeline

Snow and Ice – The RoadView snowplows provide lateral guidance and obstacle detection. Soon they will feature GPS-based location and lateral control. An advanced rotary snow blower will have automated steering, obstacle detection, and collision warning systems and use a GPS/GIS system to determine location.

Debris Vacuum – Using a joystick control from within a cab, you can vacuum behind guard rails, down into depressions, and under bushes.

Debris Removal – The Debris Removal Vehicle can pick up several tires or up to eight litter bags at one time.

Herbicide – A vision system detects weeds, aims nozzles, and automatically sprays a precise amount of herbicide.

Random Crack Sealing – A single operator can seal cracks from within a truck with a simple computer point-and-click process.

Cone Placement – The Caltrans Cone Machine can automatically lay down cones at regular intervals and then pick them up again later. Research has been very successful in showing that the cone placement process can be mechanized. www.ahmct.ucdavis.edu

Soon, cones will deploy themselves and follow trucks down the road. robots.unl.edu

Positive Separation of Lanes – Caltrans is working on a truck-mounted, expandable "Balsi Beam" that will provide work zone protection comparable to a concrete barrier. After a demonstration tour in most western states, enthusiasm for deployment is high and enhancement ideas abound even as field trials begin. NJDOT and Caltrans may also jointly explore stopping vehicles with a net or wire rope.

Longitudinal Crack Sealer – The longitudinal crack sealer automates the sealing of relatively continuous longitudinal cracks, such as those between a concrete lane and asphalt shoulders.

Bridge and Pavement Inspection – The Bridge Profile Measurement System will provide on-the-fly height and width measurements in support of over-height vehicle permitting. www.ahmct.ucdavis.edu

"Pothole Killer" – NJ DOT and Caltrans may cooperate to design a way to automatically meter asphalt to avoid under- and over-filling (which leaves bumps and cracks pavement.)

Worker Assistance – The AHMCT Debris Vacuum will soon add a "weed wacker." AHMCT has developed tethered mobile robots that can perform a variety of tasks. UC Berkeley is developing an exoskeleton to aid lifting and walking. bleex.me.berkeley.edu

AHMCT

The Advanced Highway Maintenance and Construction Technology Research Center (AHMCT) is a project oriented research center on the campus of UC Davis that develops concept vehicles and equipment for the California Department of Transportation. AHMCT has performed or directed 76 distinct projects for Caltrans and delivered 16 vehicles and 18 pieces of software and equipment.

Intent

This folio is not intended to critique present practices, judge capabilities or efforts, or define best practices. It is an attempt to describe what is happening in California with the intention to help you to understand the state of the field and challenges on the horizon. Please send comments to Robert Bosler, rhbosler@ucdavis.edu.

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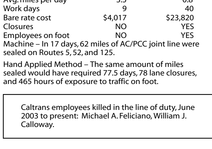

Debris Vacuum

"Pothole Killer"

Crack Sealing Machine vs Hand Applied CRAFCO

Distance Compared: 32 miles along I-5

	Machine	Hand Applied
No. of employees	3	4
Avg. miles per day	3.5	0.8
Work days	9	40
Bare rate cost	$4,017	$23,820
Closures	NO	YES
Employees on foot	NO	YES

Machine – In 17 days, 62 miles of AC/PCC joint line were sealed on Routes 5, 52, and 125.

Hand Applied Method – The same amount of miles sealed would have required 77.5 days, 78 lane closures, and 465 hours of exposure to traffic on foot.

Debris Removal

Caltrans employees killed in the line of duty, June 2003 to present: Michael A. Feliciano, William J. Calloway.

http://www.ahmct.ucdavis.edu